Air Pollution Monitoring and Control

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Abstract:-

The review paper "IoT Based Air Pollution Monitoring Using NodeMCU And MQ135 Gas Sensor" presents an innovative approach to air quality monitoring using the Internet of Things (IoT) technology. The study focuses on the utilization of the MQ135 gas sensor to measure pollution levels in the environment, with real-time data display on a webpage. The authors employ NodeMCU for data collection and transmission, interfacing with an LCD (16X2) to provide on-site pollution content visualization.The paper provides a comprehensive overview of the MQ135 sensor's internal circuit and explains the module format of the sensor, highlighting the connections necessary for implementation. Additionally, it elucidates the Arduino code used to handle the data from the sensor, connect to a local area network, and create a dynamic webpage for displaying pollution content.The operational workflow of the IoT air pollution monitoring system is outlined, with an emphasis on the threshold values for categorizing pollution levels as normal, medium, or dangerous. The authors demonstrate the system's practicality by showcasing its response to gas exposure, specifically using a lighter. This review paper serves as a valuable resource for researchers and enthusiasts interested in developing IoT-based air pollution monitoring systems, offering insights into the hardware components, code implementation, and real-time data visualization for effective environmental monitoring.

Keywords *:- IOT Technology , NodeMcu , MQ135 , Real- time data display , Air Quality Measurement.*

1. **Introduction**:

The advent of the Internet of Things (IoT) has revolutionized the way we monitor and manage environmental factors, including air quality. The paper titled "IoT Based Air Pollution Monitoring Using NodeMCU And MQ135 Gas Sensor," published on February 13, 2020, presents an innovative approach to air pollution monitoring through the integration of NodeMCU and the MQ135 gas sensor. This IoT-based solution offers a cost-effective and efficient method for measuring pollution content in the surrounding area and provides real-time data visualization on a dedicated webpage.

The project described in this paper demonstrates how a simple circuit with minimal components can be utilized to create an IoT-based air pollution monitoring system. It employs the MQ135 gas sensor, known for its sensitivity to various gases, to sense pollution levels. The sensor's output is then processed and displayed on a 16x2 LCD, making it accessible and comprehensible to users. Furthermore, the system is connected to a local area network (LAN) through NodeMCU, enabling remote access to the pollution data via a dedicated webpage that refreshes at predefined time intervals.

To understand the functioning of this project, the paper offers detailed insights into the MQ135 gas sensor's internal circuit and pin connections. The sensor's response is translated into pollution content values, categorized as normal, medium, or dangerous, based on voltage variations. These values are presented on the webpage in a visually informative manner.

The paper provides a comprehensive overview of the components required for this project, including the MQ135 gas sensor, NodeMCU, and 16x2 LCD, along with the necessary circuit connections. It then proceeds to explain the Arduino code used to control and operate the system. The code handles tasks such as connecting to a Wi-Fi network, reading sensor data, and dynamically updating the webpage with the pollution content information.

The IoT-based air pollution monitoring system presented in this paper offers an accessible and cost-effective solution for tracking air quality in real-time. Its ability to categorize pollution levels and provide a user-friendly interface makes it a valuable tool for both environmental enthusiasts and policymakers. This research paper serves as a resource for those interested in implementing similar IoT-based systems for environmental monitoring and showcases the potential of technology to address pressing environmental concerns.

In recent years, the Internet of Things (IoT) has become a pivotal technological paradigm, transforming the way we perceive, interact with, and monitor our environment. This paper, titled "IoT Based Air Pollution Monitoring Using NodeMCU And MQ135 Gas Sensor," and dated February 13, 2020, stands as an embodiment of the power of IoT in addressing pressing environmental concerns. This innovative project introduces an efficient and affordable approach to air pollution monitoring through the amalgamation of NodeMCU and the MQ135 gas sensor.

Air quality has emerged as a critical concern in an era marked by rapid urbanization and industrialization. As air pollution reaches alarming levels in various parts of the world, the need for precise, real-time monitoring is greater than ever. The project outlined in this paper sets out to tackle this challenge by providing a comprehensive solution that combines hardware, software, and IoT technologies.

At its core, this project utilizes the MQ135 gas sensor, renowned for its versatility in detecting a wide array of gases, making it an ideal choice for air quality monitoring. The MQ135 sensor's operation is rooted in its variable resistance, which fluctuates based on the gases present in the environment. This paper delves into the inner workings of the MQ135 sensor, explaining its key components, including the gas sensing material (SnO2), electrodes (Au and Pt), and a heater coil (Ni-Cr alloy) that facilitates its operation. The sensor is available in two formats, with the module format offering digital and analog output options. For this project, the module format is chosen due to its practicality.

The heart of the project is its IoT-based air pollution monitoring system, which can be assembled with a minimal set of components. In addition to the MQ135 gas sensor and NodeMCU, the system includes a 16x2 LCD display, a 10K Ohm Potentiometer, a breadboard, and connecting wires. The paper meticulously details the connections and pin assignments required to assemble the circuit effectively.

Crucially, the paper provides a detailed Arduino code that powers the NodeMCU and enables it to function as the central control unit for the air pollution monitoring system. The code ensures that the system connects to a local area network (LAN) by providing the appropriate SSID and password, allowing users to access the real-time data over a dedicated webpage. The webpage dynamically updates at regular intervals to display the most recent air quality information.

The project's effectiveness hinges on its ability to convert the sensor's analog data into meaningful pollution content values, categorizing them as normal, medium, or dangerous based on voltage variations. This categorization makes it easier for users to understand the air quality in their vicinity and take appropriate actions.

In summary, the "IoT Based Air Pollution Monitoring Using NodeMCU And MQ135 Gas Sensor" project, presented in this paper, represents a noteworthy application of IoT technology to address contemporary environmental challenges. Its low-cost, accessible, and real-time air quality monitoring capabilities make it a valuable tool for environmental enthusiasts, researchers, and policymakers. This research paper serves as a comprehensive resource for those seeking to implement similar IoT-based systems for environmental monitoring and underscores the transformative potential of technology in mitigating environmental issues.

2. Literature Review:

The integration of Internet of Things (IoT) technology with gas sensors for air pollution monitoring has gained significant attention in recent years. The project titled "IoT Based Air Pollution Monitoring Using NodeMCU And MQ135 Gas Sensor" presents an innovative approach to real-time air quality assessment. In this literature review, we explore the broader context of IoT-based air pollution monitoring, emphasizing the significance of this project in the field.

1. **IoT for Environmental Monitoring:**

IoT has emerged as a powerful tool for environmental monitoring. By connecting various sensors to the internet, it enables the collection and dissemination of data for a wide range of applications, including air quality assessment. The project's utilization of the NodeMCU, an IoT platform, is consistent with the trend of making environmental data accessible to the public in real time.

2. **Gas Sensing Technology:**

The heart of the project is the MQ135 gas sensor, a versatile component for detecting a variety of gases. Gas sensors play a critical role in air quality monitoring, helping to identify pollutants that pose health risks. The SnO2-based gas sensing material in the MQ135 sensor, combined with the heater coil, makes it suitable for detecting gases such as carbon dioxide and volatile organic compounds.

3. **Sensor Data Interpretation:**

The project's code design is worth noting, as it interprets data from the gas sensor and converts it into a percentage value, representing pollution levels. This approach simplifies data presentation and provides meaningful information to end-users. The classification of pollution levels as normal, medium, or dangerous, based on percentage values, is a practical way to convey air quality information.

4. **Web-Based Data Accessibility:**

The creation of a dedicated webpage to display air quality data is a hallmark of this project. Web-based accessibility is crucial for reaching a wider audience and increasing public awareness of air pollution issues. The refresh rate of the webpage ensures that users receive up-to-date information, making it a valuable tool for real-time monitoring.

5. **Practicality and Affordability:**

The project stands out for its simplicity and affordability. It demonstrates that IoT-based air pollution monitoring can be achieved with relatively few components and at a reasonable cost. This aspect makes the project accessible to a broad audience, including students, hobbyists, and communities interested in monitoring local air quality.

6. **Public Health and Environmental Impact:**

Air pollution poses a significant threat to public health and the environment. Real-time air quality monitoring is crucial for identifying pollution sources, assessing the effectiveness of mitigation measures, and raising public awareness. The project's ability to classify pollution levels, from normal to dangerous, underscores its potential impact on public health and environmental conservation.

3. **COMPONENTS REQUIRED:**

1. MQ135 gas sensor

The MQ135 gas sensor is a widely used gas sensor for detecting various gases in the atmosphere. It relies on a gas-sensitive material made of SnO2 and employs a Ni-Cr alloy heater coil for operation. The sensor provides analog and digital outputs, making it versatile for different applications. It can detect gases like carbon dioxide, ammonia, and various volatile organic compounds. The sensor's output is proportional to the concentration of the detected gas. It is available in both sensor and module formats, with the module version offering digital output through an additional pin. MQ135 is commonly used in air quality monitoring and safety systems.

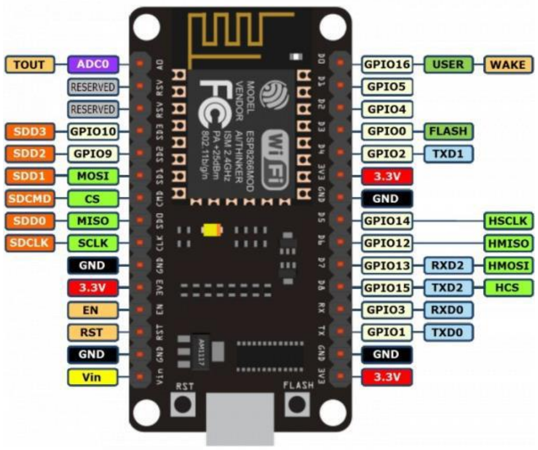
2. ESP8266 NodeMCU

The ESP8266 NodeMCU is a versatile microcontroller board that combines powerful capabilities with cost-effectiveness, making it a popular choice for IoT and embedded systems. It is designed to provide seamless connectivity to wireless networks, thanks to its integrated WiFi module. This connectivity is a crucial feature for IoT applications, enabling devices to communicate and exchange data over the internet.

One of its standout features is its compatibility with the Arduino IDE, which simplifies the programming process by allowing developers to use the well-known Arduino programming language and libraries. Additionally, it incorporates a USB-TTL converter, making it convenient for both programming and debugging.

With a range of GPIO pins, the NodeMCU offers flexibility for connecting various sensors, displays, and other peripherals. This adaptability is essential for customizing IoT solutions. Originally developed for NodeMCU firmware, this board offers additional features and support for enhanced functionality.

Despite its small form factor, the NodeMCU boasts ample flash memory, providing sufficient storage for code and data. This compact size is advantageous for projects with space constraints. Moreover, the NodeMCU is highly affordable, making it an accessible choice for hobbyists and developers looking to implement IoT projects without breaking the bank.



3. LCD (16X2)

A 16x2 LCD (Liquid Crystal Display) is a fundamental component in the realm of visual data representation. This alphanumeric display module features two rows, each capable of showcasing 16 characters, resulting in a total of 32 characters. Primarily designed for displaying alphanumeric content, it is proficient at presenting letters, numbers, and special symbols.

One of its notable attributes is the inclusion of a backlight, which enhances visibility in low-light conditions. The HD44780 controller is a prevalent choice for many 16x2 LCDs, simplifying the integration of these displays with microcontrollers. Typically employing a parallel interface, they are particularly well-suited for microcontroller-based projects, allowing for efficient data transmission and control.

Additionally, users can create and display custom characters and symbols, offering flexibility in data presentation. These displays are also lauded for their energy efficiency, consuming minimal power, making them viable for battery-powered devices. As a result of their versatility and reliability, 16x2 LCDs are

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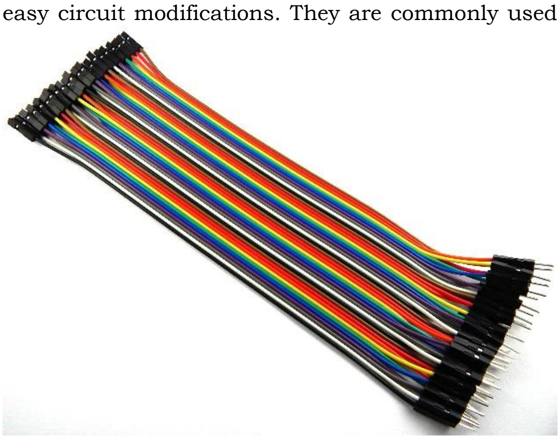
extensively used in various applications, including digital thermometers, timers, and an array of electronic devices, where conveying information in a user-friendly and legible format is essential.

4. 10K Ohm Potentiometer

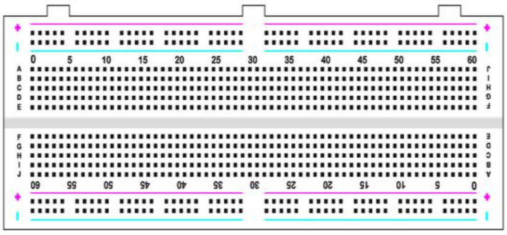
A 10K Ohm Potentiometer, often referred to as a pot, is a variable resistor with a resistance of 10,000 ohms (10K ohms). It consists of a resistive track with a movable wiper that can be adjusted to change the resistance value. Potentiometers are commonly used in electronic circuits for applications like volume control, tuning, and voltage regulation. They provide a variable output voltage depending on the wiper's position, making them useful for fine-tuning analog signals. Potentiometers come in various physical forms, including rotary and linear, to suit different applications.

5. Breadboard

A breadboard is a fundamental tool in electronics prototyping. It provides a platform for assembling and testing electronic circuits without soldering. It typically consists of a grid of holes for inserting components and interconnected metal strips underneath to create electrical connections. Breadboards are reusable and allow for quick and easy circuit modifications. They are commonly used



by students, hobbyists, and engineers to experiment with circuit designs and verify their functionality before final implementation on a printed circuit board (PCB). Breadboards come in various sizes, with the most common being the standard 830-point and mini 400-point configurations.

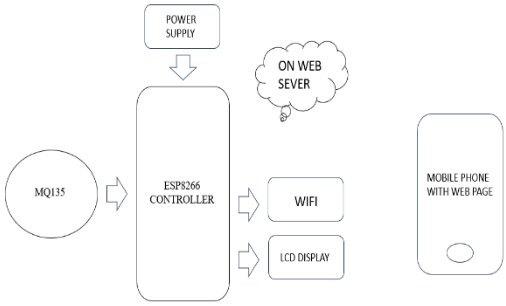


6. Connecting Wires

Connecting wires are essential components in electronics and electrical applications, serving to establish electrical connections between various components. They are typically made of conductive materials, such as copper or aluminum, and come in various gauges and lengths to suit specific needs. These wires are often insulated to prevent electrical shorts and protect against external factors like moisture and heat. Their color-coding helps identify the purpose of each wire, making it easier to connect components correctly. Connecting wires are used in a wide range of applications, from simple circuit connections to complex wiring in industrial and residential settings.

7. BLOCK DIAGRAM AND WORKING:-

We are using the Arduino IDE to write the code. To write the code for this IoT pollution monitoring project we are keeping in mind that first, our code has to connect the local area network by using the credentials provided in the code. After that, our code has to work on getting the input from the sensor, and then it must display the data on the webpage, which is created using nodeMCU. Please note that we are not dealing directly with the ppm. We are calculating the voltage variations with respect to the pollution content in the air. If the output voltage of the MQ sensor is less than 20% of the max voltage value, we considered it a normal amount of pollution content present in the air. If the output voltage is increased and stabilizes in the range of more than 20% to less than 70%, then it is considered as a medium amount of pollution content present in the surrounding air. If the output voltage increases more than 70% of the maximum value, then it is considered as dangerous level. These values are transmitted and shown at the webpage.



In the beginning, the nodeMCU is operated in station mode and waits for an active LAN to connect. After connecting to a LAN, it will display the IP address by which we can visit the webpage and monitor the data. We display the IP address over the serial monitor. Note down the IP address and enter this IP address in your web browse to monitor the pollution content on the webpage. To check the working of the MQ sensor, you can just test it by providing any gas near to it. As shown in the video below, I just used a lighter to test the working of the MQ sensor. If the pollution content is more than 20% of the maximum value, then I considered it as normal. If the value is more than 20% and less than 70% of the maximum value, then it is medium, and if the value is more than 70% of the maximum value, then it is considered as dangerous level.

The IoT-based air pollution monitoring system provides an accessible and practical solution for tracking air quality. It empowers users to stay informed about pollution levels in their vicinity through a user-friendly webpage. By integrating the MQ135 gas sensor and the NodeMCU microcontroller, the system offers an affordable and efficient tool for environmental monitoring and public awareness.

8. Applications:-

1) Industrial perimeter monitoring
2) Indoor air quality monitoring.
3) Site selection for reference monitoring stations.
4) Making data available to users.

9. Advantages:-

1) Easy to Install
2) Updates On mobile phone directly
3) Accurate Pollution monitoring
4) Remote location monitoring

10. Conclusion:-

To improve air quality, a method for monitoring ambient air quality utilizing an Arduino microcontroller and Internet of Things technology is suggested. The process of monitoring different environmental factors, like the air quality monitoring issue raised in this study, is improved by the usage of IOT technology. Here, the Arduino is at the center of the project, and the MQ135 and MQ6 gas sensors are used to sense several types of harmful gas.

which oversee the whole procedure. The process is connected to the internet via a Wi-Fi module, and the visual output is shown on an LCD.

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